By-Passes—Their Use, Effect and Control

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One of the perplexing ingredients of the highway problem is the traffic. As this traffic daily increases, we find more roads and streets incapable of handling freely and economically our fast and efficient motor vehicle. We find that congestion and accidents have become a problem of national concern.

It is ironic that the state-wide highway planning surveys, which were begun in the early 1930's to evaluate the needs of our rural highway system, should indicate that this problem was most serious in the urban areas. It was found that traffic movement was relatively unimpeded in the open, undeveloped rural areas, but was forced to submit to virtual strangulation in and near the cities. Furthermore, it was found that about 50 per cent of the total miles of vehicle travel occurred on city streets and that the short trip of 20 miles or less in length accounted for about 85 per cent of all rural and urban trips.

Later, origin-destination surveys of metropolitan areas indicated that traffic not only was concentrated in and near urban areas, but that a large percentage of traffic approaching a city was destined for it (Figure 1). For example, a city with a population of 10,000 to 25,000 has an average of 62 per cent of its approaching traffic bound for the city; a city of 25,000 to 50,000 has 72 per cent.

As a result of these planning studies and traffic surveys, it was concluded "that the kind of traffic for which our road systems should be designed is a traffic that moves short distances, not long—a traffic that moves in great volume into and out of the cities, but dwindles to much smaller proportions as cities are left behind. It is the relatively short sections of main highways near cities, now dangerously clogged by the local multiplication of short movement, that first attention should be given . . ." (3).

In a study of interregional highways which outlined a national system of highways, it was further noted "that the interregional routes, carrying a substantial part of the traffic, should penetrate

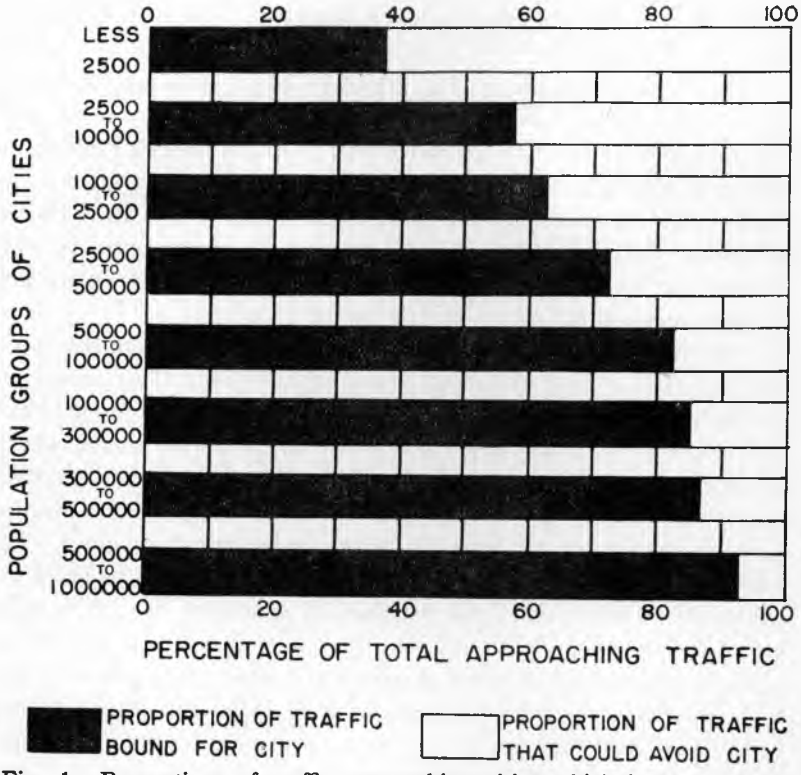

Fig. 1. Proportions of traffic approaching cities which is bound for or beyond the city.

within close proximity to the central business area . . . Since these routes should be designed to serve important arterial flows of intraurban, as well as interurban character, their locations from the fringes to the center of the city should be determined in large degree by the location of internal areas in which are generated important volumes of the intraurban movement . . ." (*7*).

The Federal-Aid Highway Act of 1944 proceeded to focus attention on the city by the annual appropriation for three years of 125 million dollars for exclusive use in urban areas. Each succeeding act has followed the example of 1944. In addition, the Act of 1952 provided supplementary funds by permitting, under certain conditions, the use of defense-access-road funds for the improvement of a circumferential highway around a city, or a radial intracity route.

The state of Indiana also has recognized the nature of the problem and began as early as 1923 to cooperate with the small communities in an attempt to alleviate the traffic problem. A legislative

act of 1937 extended the service to all cities except Indianapolis, and in 1945 routes through Indianapolis were included.

The actual solution of the urban problem, however, has been, and still is, more difficult. A natural conclusion is to regard the cities as mere barriers to the movement of traffic and to remove the effects of these barriers by constructing by-pass routes around them. Such a solution obviously expedites the movement of traffic which is not bound for the city; but, since this type of traffic may be only a small part of the total, the by-pass could be a very expensive and inadequate solution.

Because the by-pass conclusion is so natural, a popular movement has arisen from the motorists, from the public, and even from the highway engineer to by-pass the population areas through which our principal highways are constructed. This movement, however, has not met with unanimous approval. Some so-called "conservative" citizens have objected because they dislike changes—an objection based primarily on the large financial considerations involved. The businessmen, as a group, have generally resisted efforts to build by-passes in the belief that large numbers of customers would be taken out of the business district and that financial ruin would result. Some highway engineers and other citizens have opposed by-passes of the type generally constructed because of their belief that they are only partial and inadequate solutions to a tremendous urban congestion problem. This latter group has campaigned for a bolder and more far-sighted approach, and has offered multi-lane expressways or other limited-access-type-facilities through the city as more practical solutions—practical for traffic in the city and destined for the city, as well as that destined beyond the city—practical for the future as well as the present.

This popular movement for by-passes, as well as the opposition to it, was recognized by the Congress of the United States in an Act of 1950 which made it mandatory for public hearings to be held in any city where a by-pass was contemplated (5).

In Indiana, this movement has resulted in the construction of a number of by-passes—Lafayette, Columbus, Lebanon, Kokomo, and several others—and the demand for them around cities in all parts of the state. Studies are already underway to locate by-passes in some of these and the demands for similar action in other cities are increasing in volume.

It was with these facts and knowledge in mind that the Joint Highway Research Project in cooperation with the Metropolitan Area Traffic Survey Unit of the State Highway Commission of Indiana,

undertook to investigate the use and effects of by-passes. Two were selected—the by-passes at Kokomo and Lebanon, Indiana. Both were under construction, but neither had been opened to traffic when the study began. Various traffic and economic studies were made in each city before the by-passes were completed and then were repeated six months after they had been opened to traffic. Data on traffic volumes and patterns, land use and value, traffic accident severity and numbers, and business conditions and effects were collected, analyzed, and compared for both periods. The conclusions of these studies form the basis of this report.

THE CITIES STUDIED

Kokomo is a rather typical Indiana city in the 25,000 to 50,000 population group. It is located near the center of the state, has a population of approximately 35,000, and has two federal routes (U.S. 31 and 35) and one state route (S.R. 22) passing through it (see Figure 2). These routes serve traffic from all sections of the state and especially traffic between Indianapolis and northern Indiana or the industrialized areas near Chicago and in southwestern Ohio. Kokomo is a growing industrial city in the center of an agricultural area.

Lebanon, on the other hand, is a small static community of less than 10,000 population. It is also situated in an agricultural community, but is not heavily industrialized. U.S. 52, the principal route between Indianapolis and the Chicago area, passes through the city and two other routes, S.R. 32 and 39, serve the city.

The by-pass at Kokomo was constructed to accommodate the through traffic of U.S. 31, while the one at Lebanon was for U.S. 52 (see Figures 3 and 4). It may be observed that the by-pass at Kokomo is located in or very near the outskirts of the city, while the one at Lebanon is some distance from the city. Each by-pass route is slightly longer than the corresponding city route.

USE OF THE BY-PASSES

Traffic data were collected during two external type, origin and destination surveys. One of these surveys was conducted "before" and the other six months "after" the opening of the by-passes to traffic. The origin, destination, trip purpose, number of persons, place of registration, commodity carried, and purpose of stop if applicable, were obtained. Volume counts, travel-time runs and other traffic studies supplemented these data.

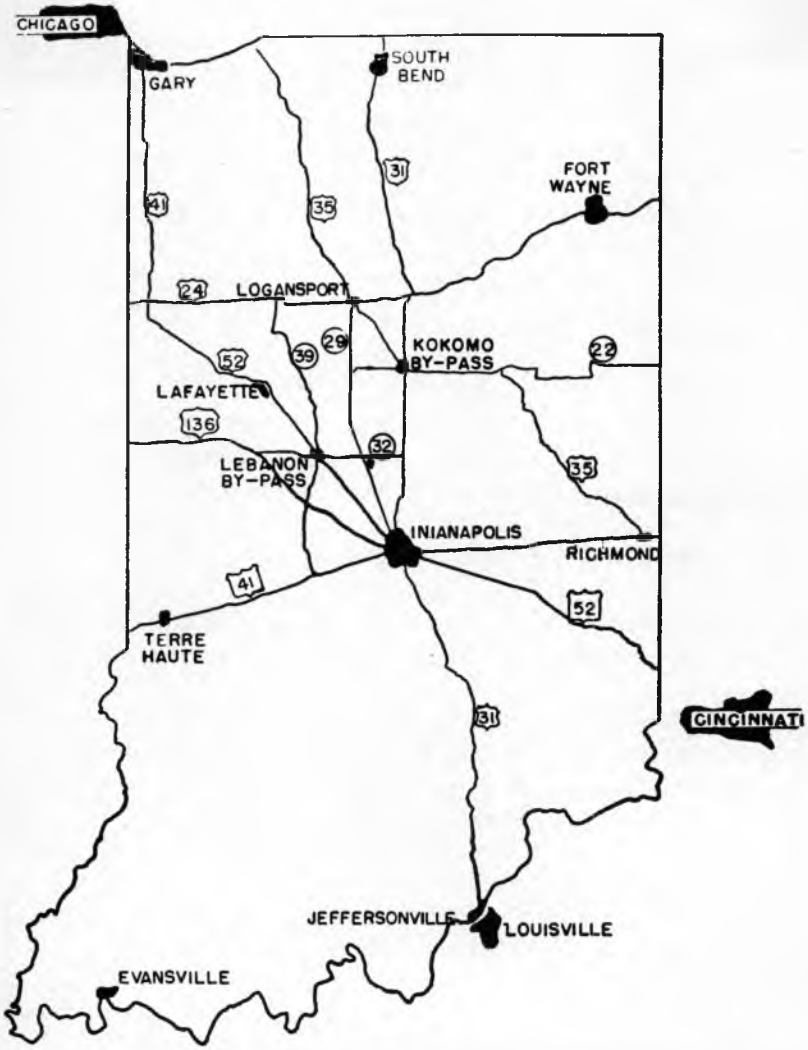

Fig. 2. Principal highway routes serving Lebanon and Kokomo, Indiana.

The traffic patterns in the two cities were then determined. These patterns, consisting of the desired movements as well as the actual movements of traffic, are shown in the accompanying charts. At Kokomo, the desired lines of movement (Figure 5) indicate a fairly heavy through movement (about 1,300 vehicles) on U.S. 31 and other heavy movements to the downtown and industrial sections of the city. In fact, only 22 per cent of the traffic approaching the city on U.S. 31 was not destined for the city. The actual flow of

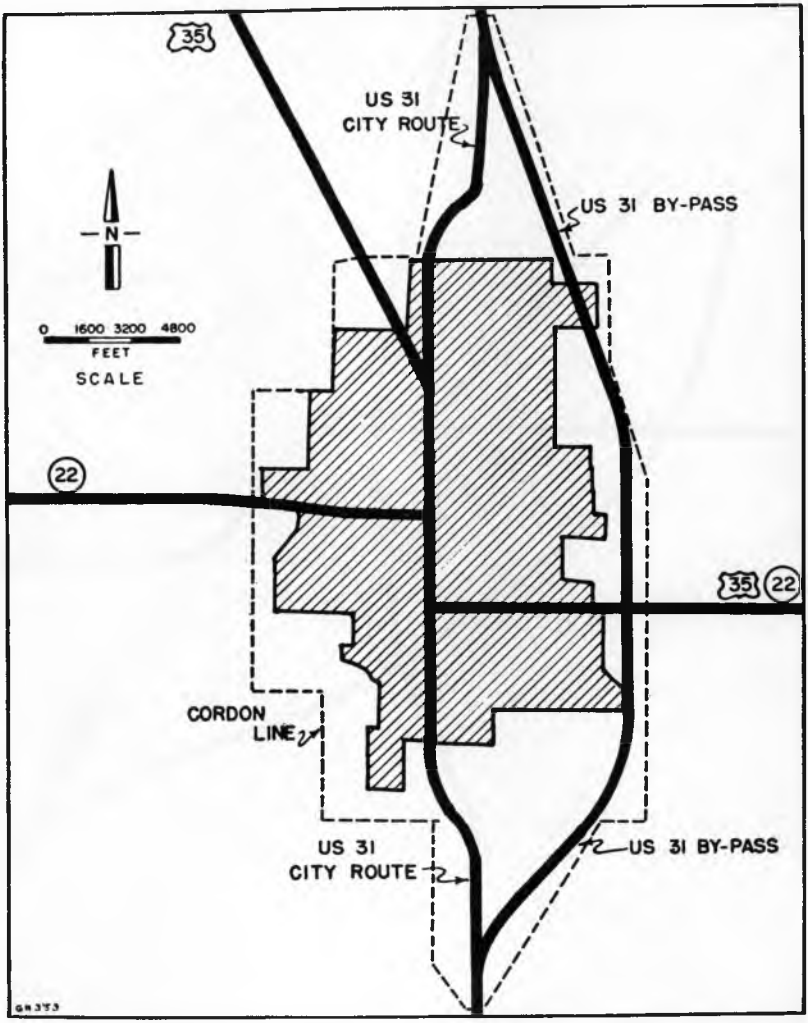

Fig. 3. Kokomo, Indiana, with highway routes and area of study.

traffic, both "before" and "after" is shown in Figure 6 and Table 1. "Before," when all of the traffic on U.S. 31 was forced to move through the city, the maximum volume was slightly over 14,000 per average weekday and occurred in the downtown area. Through trips constituted less than 17 per cent of this total. "After" the by-pass, when traffic on U.S. 31 could avoid the city, the traffic volume at the same location in downtown Kokomo was over 12,800. This is a decrease of only 1,200 vehicles or less than 10 per cent. This volume reduction is quite small and normal traffic increases will, within a

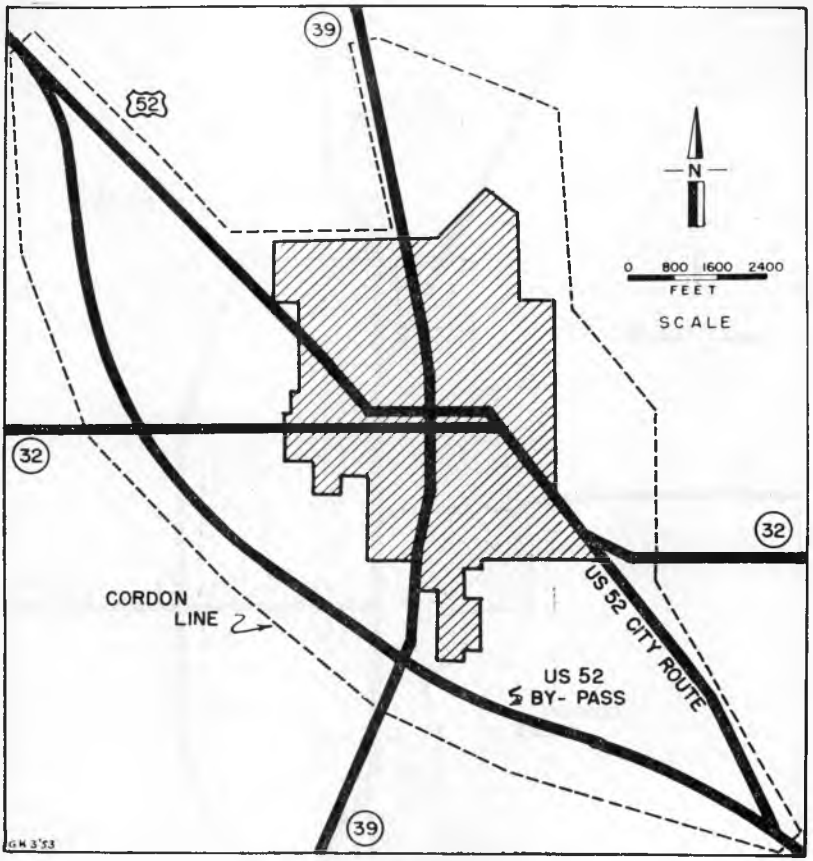

Fig. 4. Lebanon, Indiana, with highway routes and area of study.

short period of time, result in more traffic than ever in this area. In fact, congestion was present on this street "after" the by-pass, because the volume was still greater than the street capacity.

The by-pass did effectively route the through traffic on U.S. 31 around the city as about 90 per cent of this type traffic used the by-pass. This diversion included over 300 trucks which were thus removed from the city streets. A large portion of the trips on the by-pass are, however, by local vehicles. It is used extensively as a collector and distributor of traffic from or to the city, and about 17 per cent of the total usage is by trips with both origin and destination inside the city. These intracity trips are actually using the by-pass as a city street and result in an uneven flow of traffic on the by-pass. The central section, for example, has twice as much flow

Fig. 5. Major desire lines of external travel for all vehicles at Kokomo, Indiana.

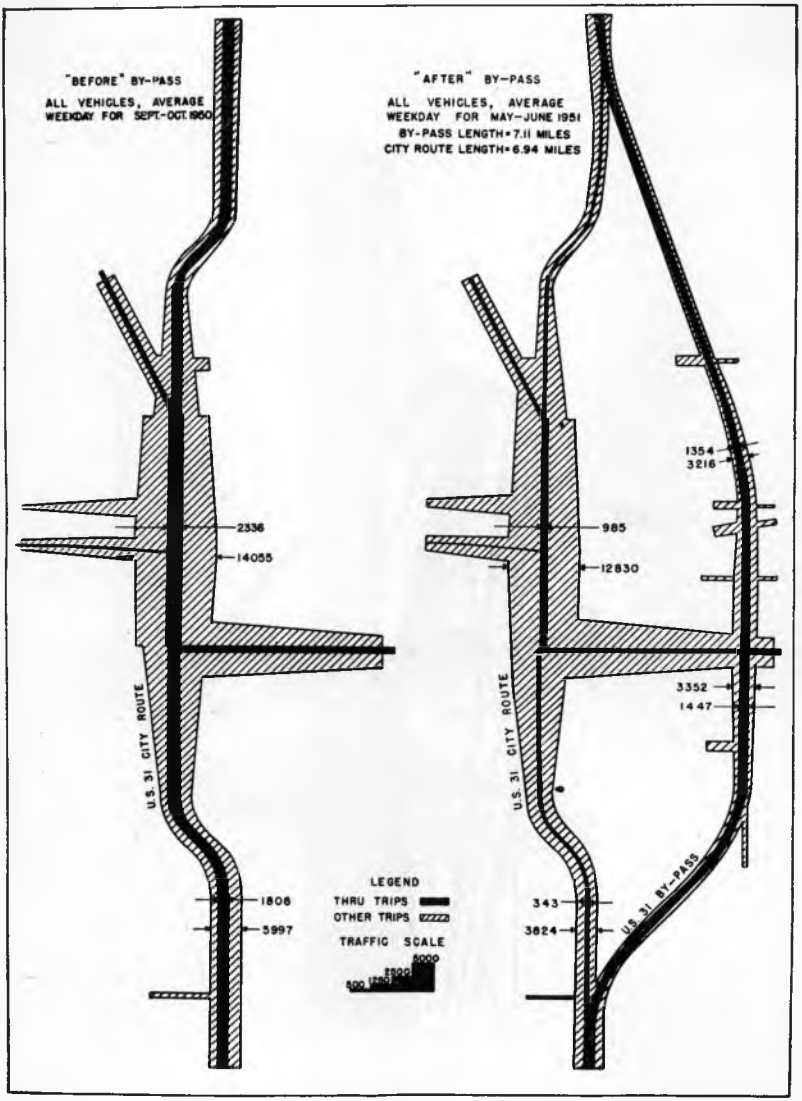

Fig. 6. Traffic volumes at Kokomo, Indiana, "before" and "after" by-pass.

as the north and south sections. There can be little doubt but that this heavy use of the Kokomo by-pass by local trips is a direct result of the proximity of the by-pass to the city. It was found that about 95 per cent of the local trips that used the by-pass had both termini of their trip within one mile of the by-pass. This use by intra-urban trips is of advantage to the city, but since the by-pass is a

considerable distance from the business district, the relief to city streets is hardly noticeable in the highly congested downtown area.

The traffic pattern at Lebanon, however, is of a different type. About 60 per cent of the traffic approaching this city on U.S. 52 is not destined for it (see Figure 7). The one outstanding movement of traffic is the heavy through movement on this route. As would be expected, this movement uses the by-pass—again approximately

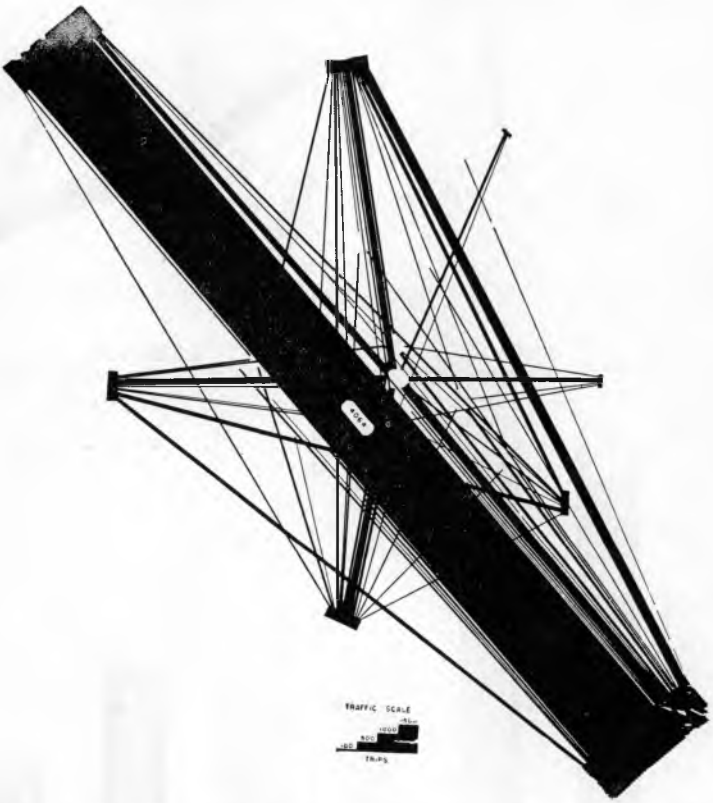

Fig. 7. Major desire lines of external travel for all vehicles at Lebanon, Indiana.

90 per cent of it (Figure 8). Prior to the by-pass the traffic at a downtown point was slightly over 9,900 vehicles while after the by-pass the volume at the same point was about 4,800 on an average weekday. This great decrease in volume (over 50 per cent) resulted in a tremendous traffic improvement in downtown Lebanon. The by-pass, in this instance, not only expedited the movement of through

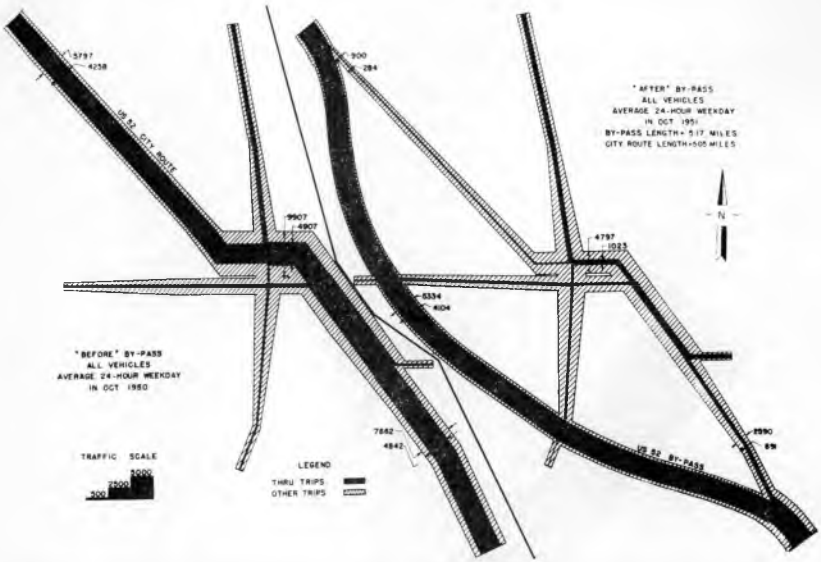

Fig. 8. Traffic volumes at Lebanon, Indiana, "before" and "after" by-pass.

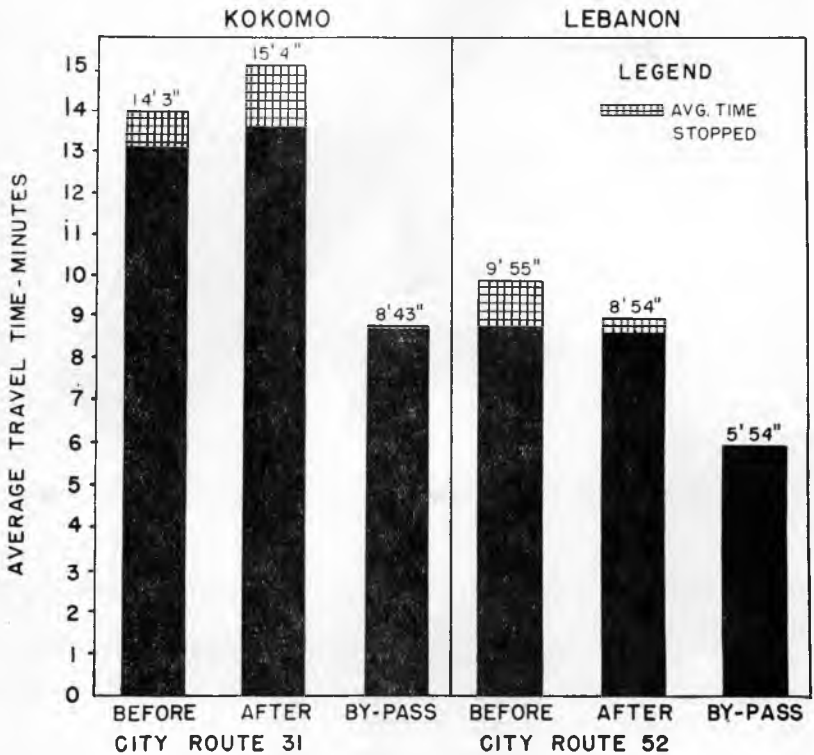

Fig. 9. Average travel times for by-passes and by-passed routes.

traffic, but also vastly improved the congestion problem inside the city.

Almost none of the traffic on the Lebanon by-pass is strictly local traffic—a direct result of its location away from developed sections of the city. Because of the relatively weak desires for movements to any part of the city, this exclusion of intraurban traffic from the by-pass is commendable.

Travel-time studies of the routes in the two cities further emphasized the effects of the by-passes on the relief of congestion in the two cities (see Figure 9). In both cities, through traffic by use of the by-passes saved between 4 and 5 minutes of time over that necessary "before" their construction. In addition, a savings of a full minute resulted to traffic on the old route in Lebanon "after" the by-pass because of freer movement on this route. In Kokomo, however, it actually required one minute longer to move through the city on the old route "after" the by-pass than it did "before." As has already been noted, the decrease in actual volume on the old route was quite small and congestion was still present. Moreover, it is generally recognized that local traffic desires to travel slower in downtown areas than through traffic, and perhaps after the "push" from through traffic was removed by diverting it to the by-pass, the local traffic assumed a more desired, "window-shopping" speed.

Here, then, we have seen two cities, two by-passes, and two results. One result was a solution to both the through traffic problem and the downtown congestion problem. One solved only the through traffic problem. To solve the downtown congestion problem in Kokomo, additional methods must now be tried. This discussion should not be construed as a condemnation of the Kokomo by-pass. In fact, the benefits to through traffic, in the form of time saved and lower vehicular operating costs, are greater than the costs of this facility. This may be true in other cities where by-passes have been suggested, but it does not alter the fact that the basic highway problem is not solved in such cases, that other remedial measures must soon follow, and that a thorough study of the traffic patterns within the urban area is necessary to determine if a by-pass or any other type facility is a solution. These studies, commonly called metropolitan area traffic surveys, must be the basis for an accurate analyzation of the highway problem within the city. These are currently being made in Indiana at the rate of 2 to 3 per year.

OTHER EFFECTS OF THE BY-PASS

Effect on Accidents. A tabulation of the accident data for both by-passes for periods of "before" and "after" is shown in Table 2. The accidents on the former routes through both cities were less in number after the by-passes than before them. The accidents which occurred on the by-passes in these periods, however reduce the encouragement indicated by such statistics. The number of accidents on the by-passes, when compared with the decrease in number of those on the old route, can be considered favorably with accident trends in other cities. Due to increased speeds on the open highway, however, the accidents which did occur on the by-passes were probably much more severe than if they had occurred on the old routes. The number of deaths, two on the Kokomo by-pass and one on the Lebanon by-pass within the first six months of operation, certainly offset any economic benefits that resulted from the decrease in accidents on the city routes.

Effect on Land Use. Before 1945 the areas through which the two by-passes now pass were almost entirely farmland. As soon, however, as planning for the by-passes began, interested individuals began developing the land to fit the needs of the travelers on the new facilities. The land use of the by-pass area at Lebanon for 1945, 1950, 1951, and 1952 is shown in Figure 10. This is very

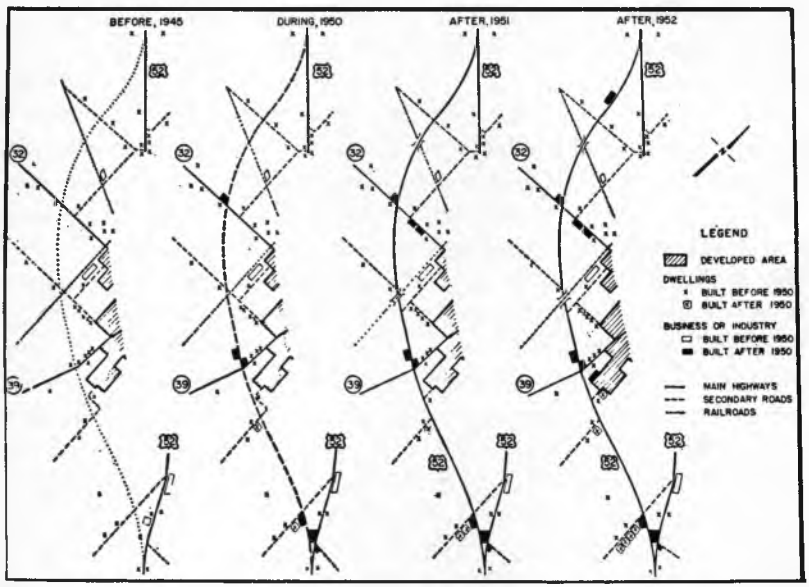

Fig. 10. Development along Lebanon, Indiana, by-pass at intervals of time since construction.

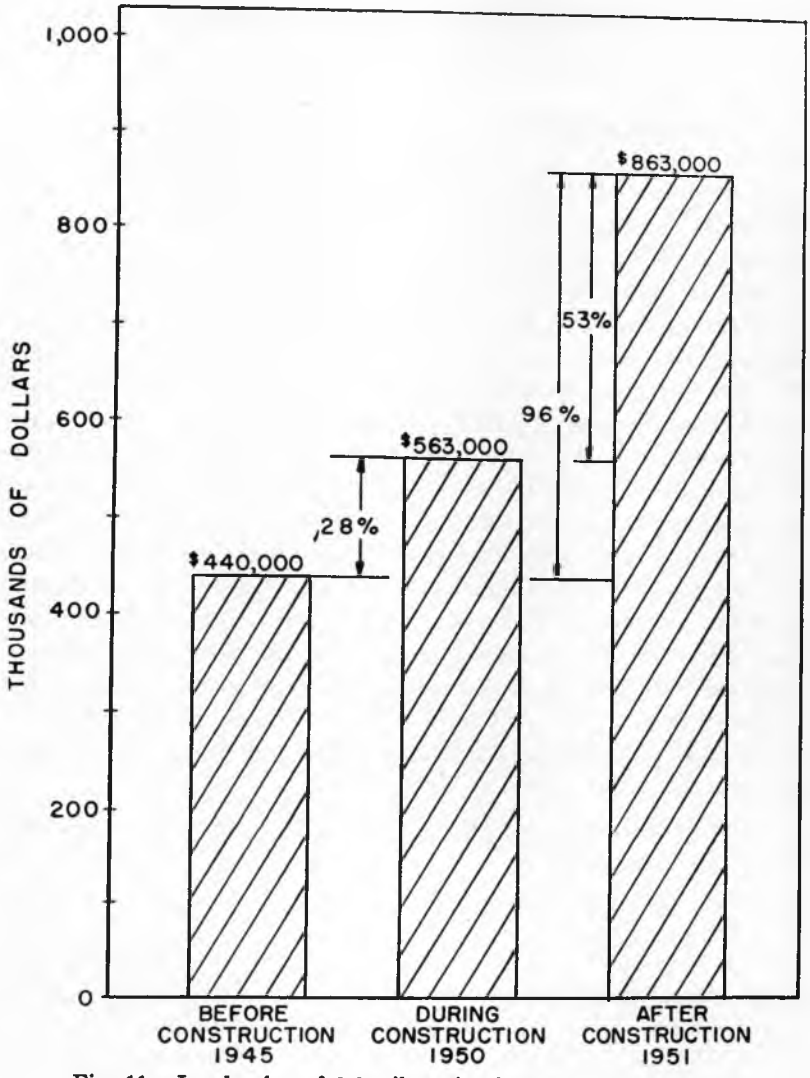

Fig. 11. Land value of 0.6 mile strip along Lebanon by-pass.

similar to the development which occurred at Kokomo. At both locations, development of the areas especially by business, which was only normally active prior to the by-passes, increased appreciably and is continuing rapidly. For example, three service stations, two restaurants, one motel, and one farm equipment store were under construction before the Lebanon by-pass was opened to traffic. Two industrial buildings, another motel, and a skating rink have since been

added. At Kokomo, within six months of the opening of the by-pass, four businesses were in operation at one intersection, and a residential area, whose only outlet is to the by-pass, contained five new residences.

Effect on Land Value. The effect on land value, as expected, has been influenced by the development of the by-pass areas. Not only does this hold true for those areas actually under development, but it also extends into all areas that border or are near the by-passes. A chart showing land values of the area along the Lebanon by-pass is shown for three different periods in Figure 11. An increase for 1951 over 1950 of 53 per cent is especially notable since most of this is attributable to the presence of the by-pass. The Kokomo effects were similar. There the land without improvements was worth approximately $500 per acre during the period before the by-pass was located. During the construction of the by-pass various parcels of land were offered for sale at about $750 per acre. As the by-pass neared completion, the asking price for this same land, spurred up by some fabulous prices actually paid for choice locations, was increased to $1,000 per acre. Various real-estate men believe that this amount would be obtained if the area were zoned for business purposes. Since only limited areas are zoned for business, these men believe that the average selling price of all land along the by-pass will be about $750 per acre. They attributed the increase of from $500 to $750 per acre solely to the presence of the by-pass and not to general increases in land values.

Effect on Business. The survey of effects on business was limited in both cities to those businesses which were located on or within a few blocks of the original route through the city. It was believed that the greatest adverse effect would certainly occur among this group. Some of the businessmen felt that the by-pass had caused them to lose the business of "through" traffic, but also had resulted in more local business for them. A few thought the by-pass actually had helped them. The information as to the reported effect on gross earnings for periods, both before and after the by-passes, is summarized in Figure 12.

Some types of businesses reported overall decreases which they attributed to the by-passes. Some tourist homes, hotels, gasoline stations, restaurants, garages, and groceries reported a decrease in business during the first few months after the by-pass from that for a similar period before the by-pass. On the other hand, others reported increased earnings. Many of the owners of the businesses which suffered decreases were, however, in favor of the by-pass. They

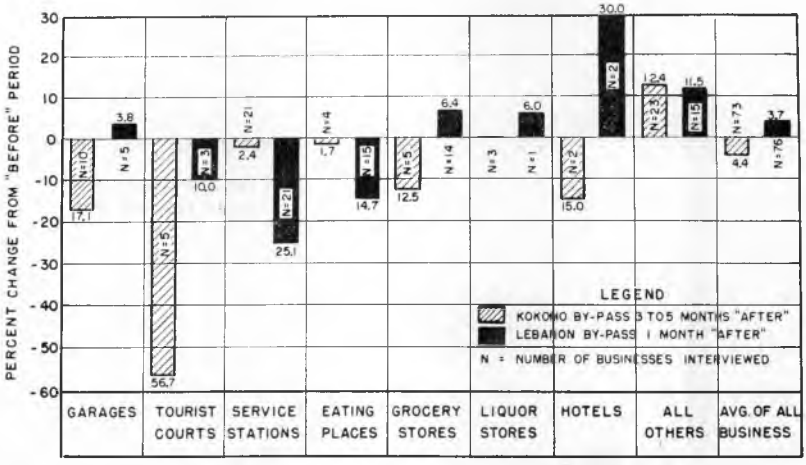

Fig. 12. Gross business comparisons for types of businesses on by-passed routes.

were certain that it relieved congestion in their area and later expected to attract more local customers.

A few fringe-area businesses which are not located in the downtown business district, but are located on the old route near the junction points of the by-pass and the old route, suffered considerably. Many of these businesses catered to transient trade and now find themselves in locations where little of that type of trade can be expected. In both cities a majority (68 per cent at Kokomo and 59 per cent at Lebanon) of all businessmen contacted were sure, six months after the by-passes were opened to traffic, that the by-passes had not hurt their business and were hopeful of obtaining more local customers. Those businesses that were most detrimentally affected were looking for more preferable locations, often on the by-pass.

During the origin-destination surveys, data were collected on the number of through vehicles that actually did stop in the two cities and the purposes for which they stopped. A summarization of these data for the two cities is shown in Figure 13. These data indicated that less than 25 per cent of the total through traffic desired to stop within the cities and that a large portion of this total, because of certain stop purposes, necessitated a stop in the city with or without the by-pass. During the "after" study, similar purpose-of-stop data indicated that a large percentage (60) of those who stopped to eat, get gas and oil, or for any purpose did not use the by-pass, but continued into the city. This information is shown in Table 3 for

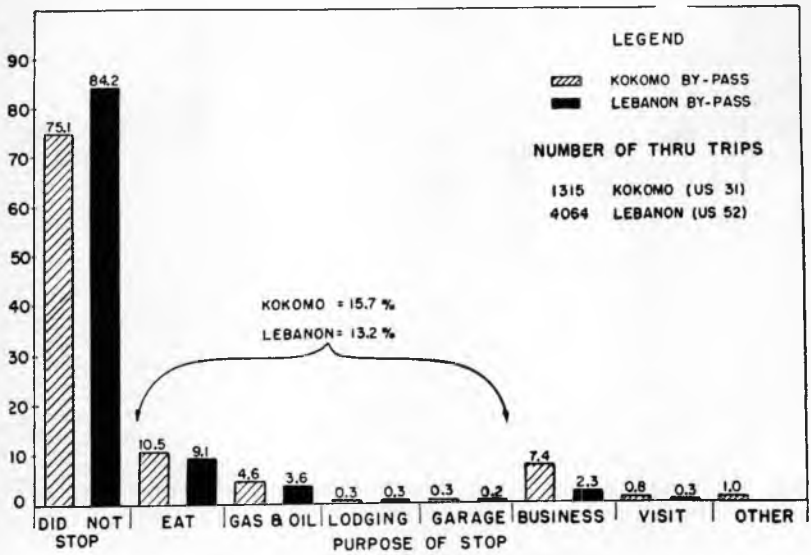

Fig. 13. Stops by through vehicles.

the Kokomo by-pass. An analysis of this information indicates that the by-pass should not adversely affect business on the former route. For example, the entire Kokomo business district with 1,315 through trips on U.S. 31, of which 24.9 per cent wished to stop in the city, lost the business of only about 130 vehicles (40 per cent of 24.9 per cent of 1,315).

CONTROL OF THE BY-PASS AREA

A major portion of the benefits from a by-pass results from benefits received by the motorist using the by-pass because of the ease of movement upon it. It is a by-pass and will remain that only as long as there occurs a savings in time, distance, or operating cost to the motorist. If there exists no such benefits, the motorist will eventually come to regard the facility as another congested city street and, in effect, the problem begins all over again. Traffic movement is then impeded as it approaches the city and the search for another solution, yes, even another by-pass, begins again.

The rapid development of by-pass areas and their none-too-good accident record emphasize the seriousness of the problem. Experience with by-passes which were constructed a number of years ago indicates that such a vicious cycle of solution-problem, solution-problem, will continue to occur under the present methods of by-pass control in Indiana. For example, the Lafayette by-pass, constructed around 1938, has gradually degenerated from a high-

speed modern highway to just another city street (see Figure 14). Development along this artery of transportation has occurred so rapidly and with such little access control so as to make widening extremely expensive and to force traffic to move at speeds far below desirable standards. Access points have been cut to residences, businesses, and factories until today some roadside areas are almot one continuous access point. The resulting traffic conflicts between slow-moving vehicles entering or leaving the by-pass at one of these

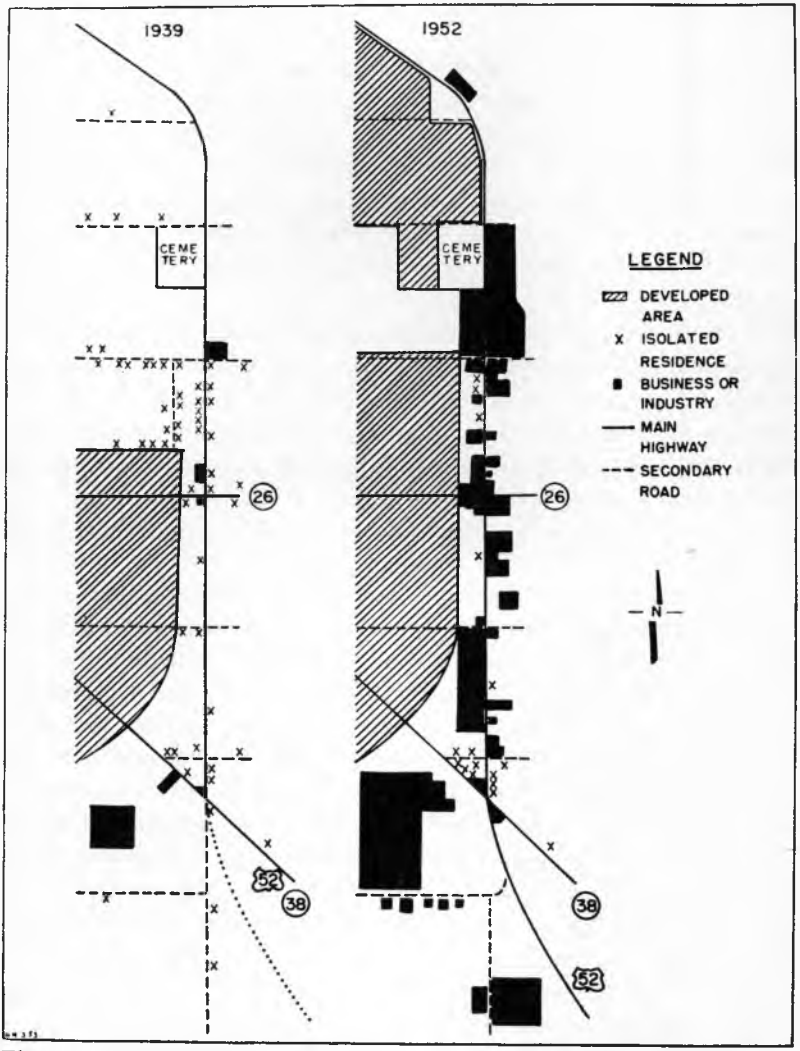

Fig. 14. Development along portion of by-pass at Lafayette, Indiana, by 1939 and 1952.

access points and fast-moving through vehicles can only result in slower movement and higher accident rates. Traffic movement is of necessity further slowed by the installation of traffic lights at a constantly increasing number of intersections.

And all of this ugly picture is already taking form on both the Kokomo and Lebanon by-passes. Access points to residences, filling stations, motels, and other businesses at Kokomo have increased from a total of 20 when the by-pass was opened to 45 within the space of two years. These, when added to the intersecting roads, gives us the astounding total of 76 access points in a distance of seven miles in only two years. Lebanon experience is similar. One cannot travel either of the two by-passes today in the time indicated in this report; in fact, the travel-time average has increased more than a minute on each. If the present rate of cutting access points is not curtailed, these two by-passes can only become more congested— more like city streets—more like the Lafayette by-pass.

When by-passes are first opened they do provide rapid movement, and it is for this reason that they are constructed. The annual benefits from this ease of movement are compared with the annual costs to determine the economic justification of the project. But then we immediately begin to dissipate these benefits by turning the by-pass area into a service facility and a storage place for vehicles—vehicles which never desired to come to the by-pass area until development occurred—vehicles which are not interested in fast movement.

A method does exist which would help protect our investment in a by-pass and insure its maintenance as an artery of free flow (8). This method, commonly referred to as limited access, is not new, but has been used by many states in the development of modern, high-speed highways. Limited access is simply restricting, by legal means, the locations at which access points may be cut. The number of locations are generally few and far apart; intersections are often separated and rights-of-way are wide. Service roads, constructed of a lower type and at a lower cost because of their use by generally lighter and slower traffic, are constructed along such limited access facilities as development occurs and often are the responsibility of a private developer. Those states which are using limited access have found that development along such a route is not generally curtailed, but in many instances is even expanded. These states are convinced limited access is a method that will insure free-moving traffic for the life of the facility—not for just a few years.

Limited access is also, because of the very nature of the facility, an important part of a toll road. It is undoubtedly one of the reasons

why toll facilities do move large volumes of traffic and are looked upon with favor by the motoring public. Perhaps the almost total absence of slow-moving traffic is one of the important reasons why motorists do not object to paying a rather high fee.

The application of limited access provisions to new facilities, such as by-passes, was authorized by legislative action in this state in the year 1945. The action authorized "the highway authorities of the state, counties, cities, and towns acting alone or in cooperation with each other . . . to plan, designate, establish, regulate, vacate, alter, improve, maintain, and provide limited access facilities for public use whenever such authority or authorities are of the opinion that traffic conditions, present or future, will justify such special facilities . . ." The same act provides authority to "establish an existing street or highway as included within a limited access facility . . ." (1)

Indiana has made only meager use of this act to date. Do present conditions and future traffic conditions that are forseen justify the use of the provisions of this act now? These by-pass studies indicate that now, at the least, is the time.

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TABLE I

Diversion of Traffic by By-Pass Average Weekday Traffic

	"Before" By-Pass	*"After" By-Pass*
Kokomo, Indiana—Traffic on U.S. 31		
Total Traffic, south of city	5736	6050
Through Trips (On U.S. 31 only)	1315	1349
Number Used U.S. 31 By-Pass	----	1110
Percent Used U.S. 31 By-Pass	----	82.4%
Total Traffic on City Route (Business District)	14055	12830
Percentage Decrease	----	8.7%
Lebanon, Indiana—Traffic on U.S. 52		
Total Traffic, south of city	6905	7298
Through Trips (On U.S. 52 Only)	4064	4290
Number Used U.S. 52 By-Pass	----	4033
Percent Used U.S. 52 By-Pass	----	94.1%
Total Traffic on City Route (Business District)	9907	4797
Percentage Decrease	----	51.5%

TABLE II

Accident Comparison on State Routes
"Before" and "After" By-Passes

	In City		*On*	*Total*
	"Before"	*"After"*	*By-Pass*	*"After"*
Lebanon, Indiana				
No. of Accidents	44	29	27	56
No. Killed	0	0	1	1
No. Injured	8	3	11	14
Ave. Damage	$184	$166	Severe*	----
Kokomo, Indiana				
No. of Accidents	205	185	33	218
No. Killed	0	0	2	2
No. Injured	23	23	9	32
Ave. Damage	$126	$134	Severe*	----

All data are for six months.

* Estimated damages were not available, but police authorities stated many vehicles were demolished.

TABLE III

Purpose of Stop Versus Route Taken of All Through Vehicles on U.S. 31

Purpose of Stop	*Total No. Trips*	*Route Used*			
		By-Pass		*Through City*	
		Vehicles	*%*	*Vehicles*	*%*
No Stop	1161	1035	89.1	126	10.9
Eat	86	46	53.5	40	46.5
Gas and Oil	37	22	59.5	15	40.5
Lodging	1	0	0	1	100.0
Business	50	5	10.0	45	90.0
Garage	1	0	0	1	100.0
Visit	11	2	18.2	9	81.8
Other	2	0	0	2	100.0
Total Stop	188	75	39.9	113	60.1